Taking Health Science out of the K-12 STEM Education Portfolio

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Abstract

Following a Presidential directive to develop a strategic plan for STEM education, the Office of Science and Technology Policy (OSTP) proposed to consolidate all K-12 programs at the Department of Education (D.Ed.), among which were NIH's entire K-12 education portfolio - the Science Education Partnership Awards (SEPA). In response NIH moved to divest itself of the SEPA programs. Here we present evidence of SEPA's unique discipline-specific functionalities focused on the biomedical K-12 STEM pipeline and health literacy that are not duplicative of any other federally funded efforts. We also discuss why transferring SEPA programs to the D.Ed. will impact critical SEPA functionalities: D.Ed. only proposes to fund school district-driven projects focused on model building, whereas SEPA projects are scientist driven and outcomes-oriented with a strong disciplinary focus and emphasis on program delivery. These caveats raise questions about how eliminating SEPA from NIH contributes to enhancing US K-12 STEM education.

'Science' has reported that in early September NIH divested itself of its scientist and physician driven K-12 health science education programs, namely the Science Education Partnership Award, administered through the Office of the Director, together with mission-specific siblings at the Institutes of Allergy and Infectious Disease (NIAID) and Drug Abuse (NIDA). Part of the motivation to eliminate the SEPA programs stemmed from a plan developed by the Office of Science and Technology Policy (OSTP) in response to a Presidential directive to '*make[s] disciplined choices to reorganize and cut back lower priority programs'* [1]. The plan attempted to identify duplicative programs, but the Government

Accountability Office (GAO) surveys on which the plan was based, indicates that the 3 NIH - funded programs (grouped together under the acronym SEPA) were actually unique in both objectives and scope [2,3]. Of the 11 'pre-secondary' (K-12) programs targeting biological sciences (the 3 SEPA programs, 5 programs at NSF and 3 programs at the Department of Education (D.Ed.)), the objectives of the SEPA programs did overlap with 2 programs at D.Ed., in that they too were designed to '*improve teacher (pre-service or in-service) education in STEM areas, and to improve or expand the capacity of K-12 schools or postsecondary institutions to promote or foster education in STEM fields'*. However, only the SEPA programs also targeted the pipeline to undergraduate STEM education. With respect to scope, the GAO survey characterized STEM fields with broad strokes: For instance 'biological sciences' did not distinguish between subsets of biology. However, applying the requisite granularity shows that of the K-12 programs targeting biological sciences, only SEPA focused on biomedical and health science. Hence the SEPA programs do appear to have unique functionalities. Thus whether they should be considered '*lower priority'* requires an assessment of their impact.

SEPA programs impact two critical areas of national interest: the biomedical workforce via the undergraduate STEM pipeline, and health literacy. Toward its goal to expand the STEM workforce both the American Association for the Advancement of Science (AAAS) and the National Research Council (NRC) have focused on elevating scientific literacy by reforming how science is taught to undergraduates, while NIH also addresses its mission-specific goal of enlarging the biomedical workforce by spending 90% of its education dollars on undergraduate and graduate education. Neglecting the pre-college population is short-sighted and negatively impacts the quality and diversity of the STEM workforce. For example, adolescents, particularly from underrepresented populations, steadily lose interest in science during their pre-college years [4]. As a result US high school students continue to display poor scientific literacy on the international benchmarks of achievement that assess readiness for college-level science studies with even lower levels of achievement by minority groups [5]. Worse, economically disadvantaged and underrepresented minority students and are more likely than higher income or white students to drop out of school altogether, further compounding these problems [6]. Lack of a diverse and well- qualified work force particularly in mid-level jobs, has contributed to slow growth in the life science/biomedical sector, even in 'biotech powerhouses' like Massachusetts [7]. Yet the same studies demonstrating adolescent disenchantment with 'school' science show that when they experience 'real-world' science they value and which mirrors their real world experience their motivation and achievement increases [8]. This implies that emphasizing topics students find inherently interesting, such as their health and disease, could impact scientific and health literacy and ultimately the biomedical workforce pipeline. All 93 current and recent SEPA projects representing 40 states focus on engaging K-12 students with real-world biomedical and health science. The majority of SEPA projects address the needs of disadvantaged students for better teachers, rigorous curricula and authentic STEM research experiences, while more than 25% are specifically designed to enhance the STEM pipeline transition to undergraduate learning [9]. Additionally the working scientists and physicians who lead SEPA projects can call on close connections to research and clinical practice to model pathways to the biomedical workforce. SEPA's successes are well documented [10] and SEPA's impact on the biomedical STEM pipeline is therefore unique and would not seem to be '*lower priority'*. It would need to be reproduced were SEPA itself eliminated.

Another unique impact of SEPA is on fostering health literacy. More than half of the US population are functionally health illiterate meaning, in the words of the Institute of Medicine (IOM), they lack '*the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions'* [11]. Inadequate health literacy causes missed healthcare opportunities that cost the American taxpayer in the order of 200 billion dollars a year [12]. A patient's failure to process and understand basic health information has been traditionally considered as a failure in communication, largely dealt with by exhorting the medical team to communicate more clearly with their patients. Both the IOM and the Health and Human Services recognize that educating the K-12 cohort in health-related science is an underexploited opportunity to foster health literacy and has recommended that this avenue be vigorously pursued [11,12]. But this presents a number of challenges: First, health in schools is usually taught from a physical fitness focus, so more health-related information is delivered in physical education than science classes. Second, even if science classes incorporated health science, science teachers are ill -equipped to teach it. Professional science teacher certification is unlikely to include courses in 21st century perspectives on biomedical and health sciences, because such topics are rarely on the undergraduate agenda, much less in education schools. More than half of all SEPA projects either address this problem by providing professional development for in-service teachers, or circumvent it by reaching the K-12 community and their parents directly, via after-school activities and museum experiences. SEPA's contribution to health literacy is therefore also unique and does not seem to be '*lower priority*'. It too would need to be reproduced were SEPA itself eliminated.

The magnitude of the science and health literacy crisis and its economic fallout suggests that, on the contrary, a SEPA-like approach bringing current health science to the classroom and community should be expanded. Perhaps recognizing this, NIH has supported the OSTP plan to consolidate K-12 programming, including SEPA, at the D.Ed. However, moving SEPA would not effectively reproduce its functionalities, even were the budget for a 'SEPA-like program' to increase significantly beyond the approximately $30M dollars per annum currently allotted. It is not merely that D.Ed. has no experience with health science education – this could be addressed by delegating suitable administrative support, which is NIH's proposal. Rather two confounding problems reflect a deep division between the education researchers who manage science education and the working scientists who drive projects like SEPA. The first is philosophical and lies in the question of what constitutes authentic science practice. Over the last 30 or so years, K-12 science education has been shepherded by education researchers who have embraced the idea that the methodology underlying science practice can be appreciated in isolation from the scientific content [13], a notion most professional scientists, particularly in rapidly evolving fields like biomedicine, find deeply flawed. Thus K-12 science education has had only peripheral involvement from scientists (SEPA, with its scientist-driven education projects has been an outlier). It is now evident that this model has failed to sustain student engagement in learning science, or to promote scientific literacy. Furthermore adults educated in this environment appear to be weak in the problem-solving skills critical for the 21st century STEM workforce [14]. Since the mid 90's scientists, under the aegis of the National Academies, have been sounding the alarm that authentic science practice requires a solid foundation in content [15] and have recently begun to have an impact, as illustrated by the Next Generation Science Standards (NGSS) [16]. From past evidence it would seem likely that education researchers will need significant support from scientists to translate the NGSS effectively. Nonetheless, the D.Ed. response to proposed STEM consolidation does not include adding scientist-driven programs to its portfolio. Rather the D.Ed. will continue only to invite proposals from school districts that have acquired higher education partners. While there are many well-established partnerships between school districts and researchers from education departments, there are few precedents for partnerships with gatekeepers of biomedical knowledge like medical schools. It is difficult to envision school district and education research-*driven* partnerships effectively emulating SEPA-like approaches in an expedited time frame that would prevent critical functionality being lost were SEPA itself eliminated.

A second confounding problem lies in how the D.Ed. would deal with SEPA-like projects. In contrast with educational research that is largely concerned with the learning and teaching process, SEPA projects are largely outcomes-oriented with a strong disciplinary focus and emphasis on program delivery in addition to model development. As such they are obliged to spend at least 10% of their budget on external outcomes evaluation, and are expected to incorporate rigorous quasi-experimental or randomized hypothesis-driven methods including the randomized control trial (RCT) where appropriate. In contrast, even though the STEM education priorities for the FY2015 budget emphasize outcomes and indicate those methodologies as preferable for project evaluation [17], they are not appropriate for many education process research projects. Consequently few education journals publish outcomes-based research. This forces many SEPA projects to publish in the public health and health communication literature rather than the educational research outlets. Compounded with the philosophical differences outlined above, these problems have conspired to limit SEPA's exposure to and impacts in the education research field, perhaps contributing to an apparent perception among the researchers that manage K-12 education that it is of '*lower priority*'.

Clearly none of the obstacles to reproducing critical SEPA functionality at D.Ed. are intractable: D.Ed. philosophy could be shifted to include authentic biomedical science practice; Program priorities could be adjusted to include outcomes-focused biomedical science education; Program design could be altered to incorporate scientist-driven projects; Program administration could be expanded to direct and evaluate outcomes focused biomedical science projects. The question becomes whether either eliminating SEPA or moving it from NIH will accomplish the '*Administration's comprehensive effort to improve STEM education'* [1]. The OSTP report indicated that criteria for success will be '*developed and refined through public and expert input'*. Clearly this input is needed before any further plans are developed.

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* This article benefited from input from many members of the SEPA community, particularly Rochelle Bloom, Jeanne Chowning, Berri Jacque, Dina Markowitz, Nancy Moreno, Scott Rawls, Patricia Thomas, Marilyn Winkleby and J. Michael Wyss.